ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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Bits to Energy Lab

→ **Now or Never? The Importance of Immediate Energy Use Feedback**

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BECC, October 20, 2015

Image: BMW

…and only receiving a message a couple of hours later...

…that your household's fleet of vehicles drove at an average speed of 45 mph this morning.

That's roughly the status of what we call "smart metering" these days in the utility sector.

→ | **Today's smart metering programs provide feedback on *aggregate* household electricity use - and generally on *past* behavior.**
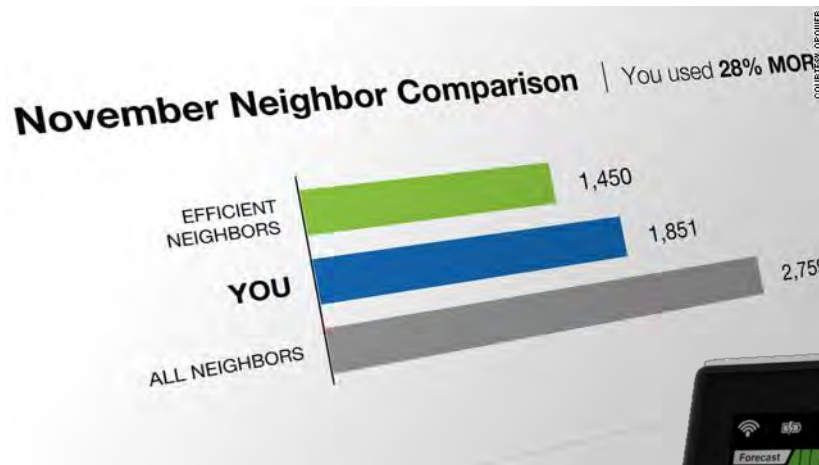
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Image: OPower

Image: GE

Image: edmi meters

- How often are web portals and in-home displays really accessed in real time, while people cook, vacuum-clean, etc.?

→ **Today's feedback is generally delivered after the behavior has taken place: Individuals can only make resolutions for the future.**

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- Feedback on **past behavior** create **general awareness** and help individuals to derive **strategies for future conservation behavior.**
  - Like New Year's resolutions…

- Can't be do better than that with smart metering?

- Some agreement that feedback should be
  - **Specific** (yet how specific?)
  - **Timely** (yet how timely?)
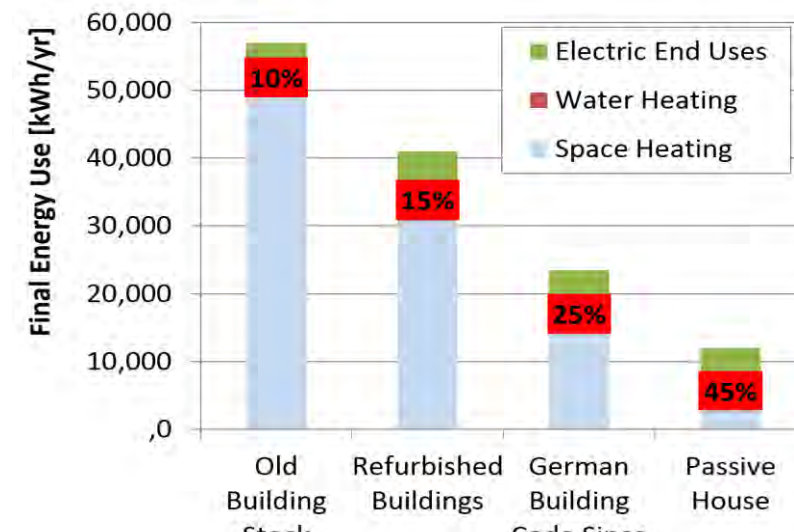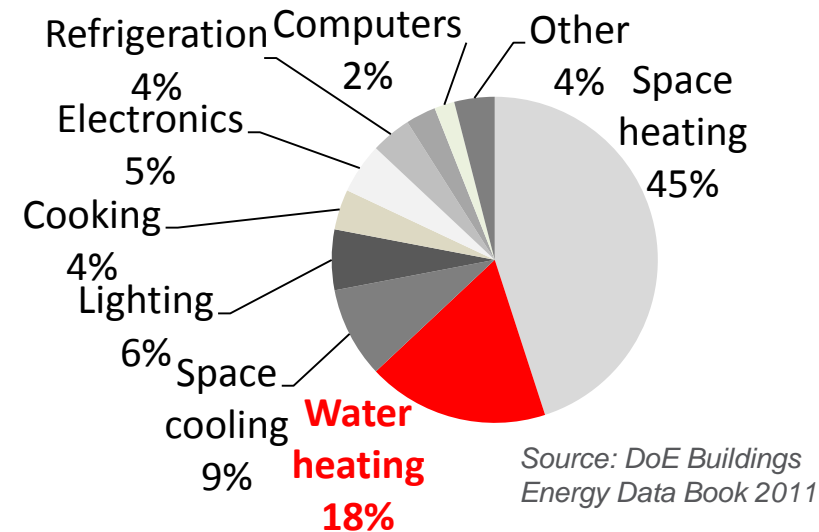 - **Frequent** (results inconclusive)

- Let's do it!

Angus & Phil BY ANNIE TAYLOR LEBEL

WHAT EXACTLY IS "A NEW YEARS RESOLUTION"?

IT'S A "TO DO" LIST FOR THE FIRST WEEK OF JANUARY.

Why feedback on shower behavior?

- Water heating: 2nd largest residential energy end use

- High degree of user control

- Few distractions

- With better insulated houses, the share of water heating will increase considerably

Refrigeration 4%
Electronics 5%
Cooking 4%
Lighting 6%
Space cooling 9%
Water heating 18%
Computers 2%
Other 4%
Space heating 45%

Source: DoE Buildings Energy Data Book 2011

Final Energy Use [kWh/yr]

■ Electric End Uses
■ Water Heating
■ Space Heating

- Old Building Stock — 10%
- Refurbished Buildings — 15%
- German Building Code Since — 25%
- Passive House — 45%

- Average shower lasts 4 minutes

- Requires 2.5 kWh of energy

- Enough to power 2,200 (!) CFLs (17 W) during the same time…
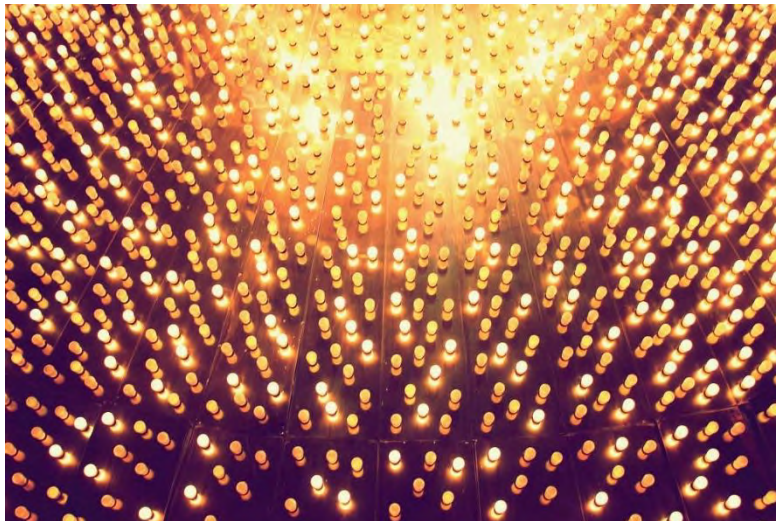
→ **We use amphiro a1 smart shower meters to capture granular data on actual behavior and consumer response to different behavioral interventions.**

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spin**off**

ETH *Zürich*

The **standard amphiro a1 shower meter** displays / stores

- Water consumption
- Energy consumption
- Water temperature
- Energy efficiency class
- Polar bear animation

per shower

Activated automatically ("data push")

- No battery – the device harvests energy from the water flow

First randomized controlled trial with 697 households in Zurich in 2012

- Survey data (socio-demographics, personality, environmental attitude…)
- Sample had also completed an electricity smart metering study

ewz
Die Energie

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE

In our 2012 study, the smart shower meter reduced energy use by 22% - yielding a much larger conservation impact than electricity smart metering.

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- **Average conservation effect of 22% (!)**

- **Also much larger absolute impact** than electricity smart metering study with the **same pool of households**

Yearly reduction	Electricity smart metering study	Smart shower meter study
Energy – relative consumption change	3.2% of household electricity	22% of shower energy
Yearly energy savings	86 kWh	443 kWh
Yearly CO_2 savings	9 kg (US electricity mix: 56 kg)	98 kg (US mix water heating: 190 kg)
Yearly water savings	/	2250 gallons
Yearly cost savings	$25	$140

Factor 5

Factor 11

- **Key learning of our first study:**

Real-time feedback on a specific behavior can yield a much larger impact than the provision of broader feedback.

- **Open questions:**
  - How essential is the immediacy of feedback?
  - To what extent can we transfer this to other behaviors? Or is showering just "different"?
  - Can we replicate the effect size elsewhere?
  - Role of goals, social norms,…
  - Can we replicate the large effect with other samples?

→ **New study** in 2015 in collaboration with **Swiss Mobiliar Insurance** (sustainability employee engagement program)

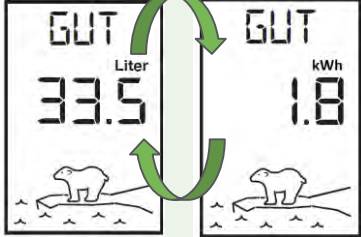*Die* **Mobiliar**
Versicherungen & Vorsorge

amphiro

- 726 households recruited all over Switzerland (employees of Mobiliar insurance and their families)

- **Measurement data**:

  - 641 households (89%)

  - 65'140 showers

- **Survey data**

  - Socio-demographics, environmental attitude, personality traits, perception of the device,…
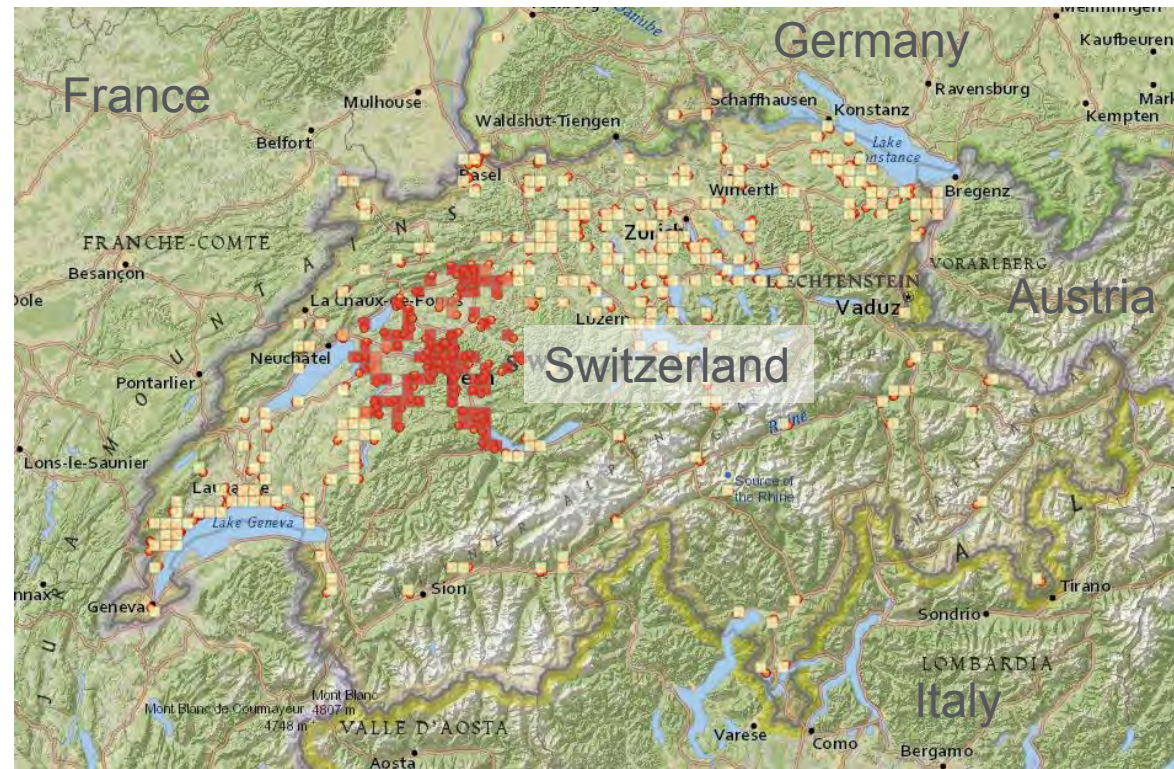
Our research design allows us to differentiate the impact of feedback *during* the behavior and feedback *right after* the behavior.
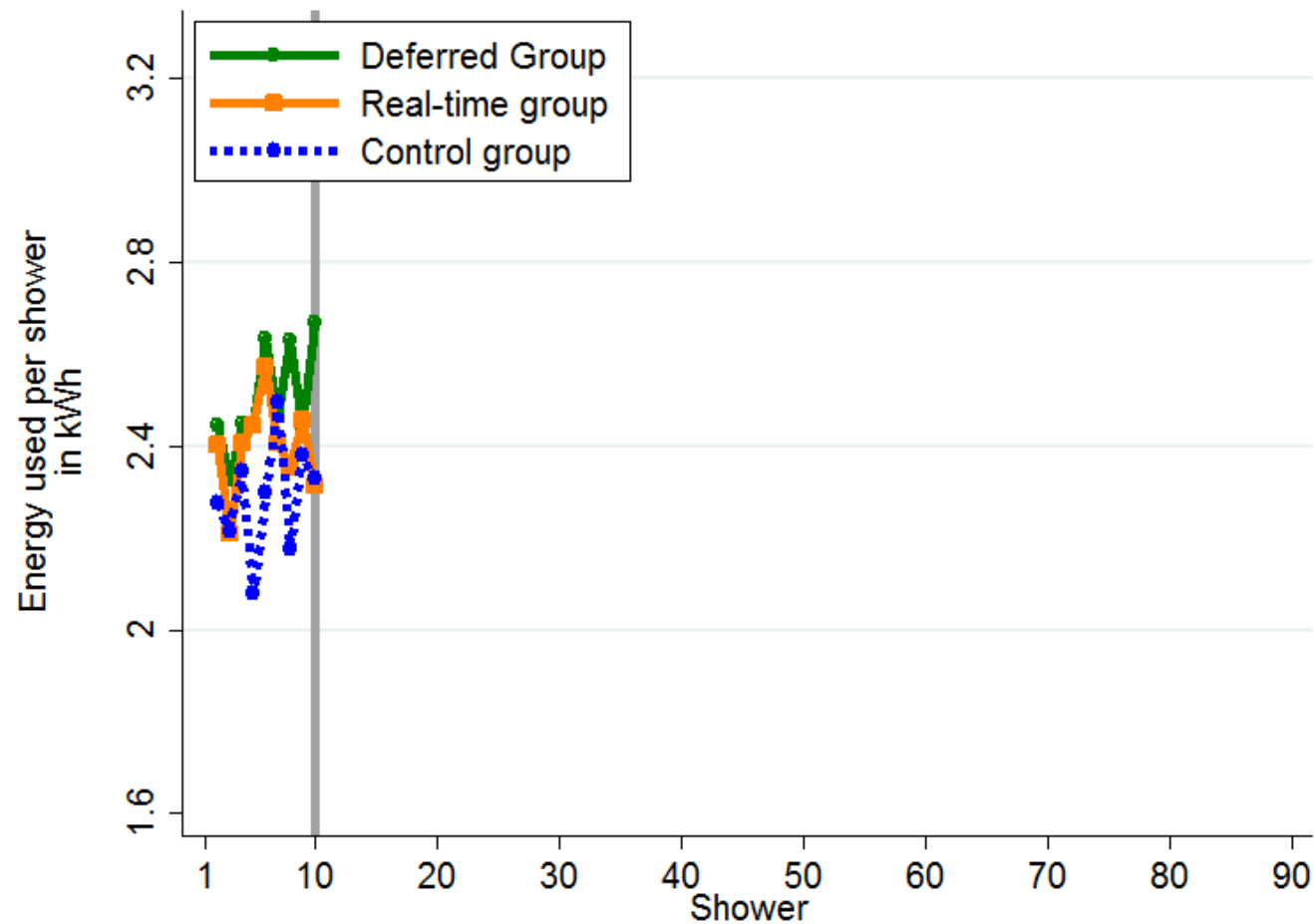
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	Base-line (#1-10)	During shower (#11+)	After shower (#11+)
Real-time group	°C 36	GUT 23.8 Liter	GUT 33.5 Liter / GUT 1.8 kWh
Deferred feedback group	°C 36	°C 36	GUT 33.5 Liter / GUT 1.8 kWh
Control group	°C 36	°C 36	°C 36

Note: Still feed-back on a **specific** action, given *almost* instantly
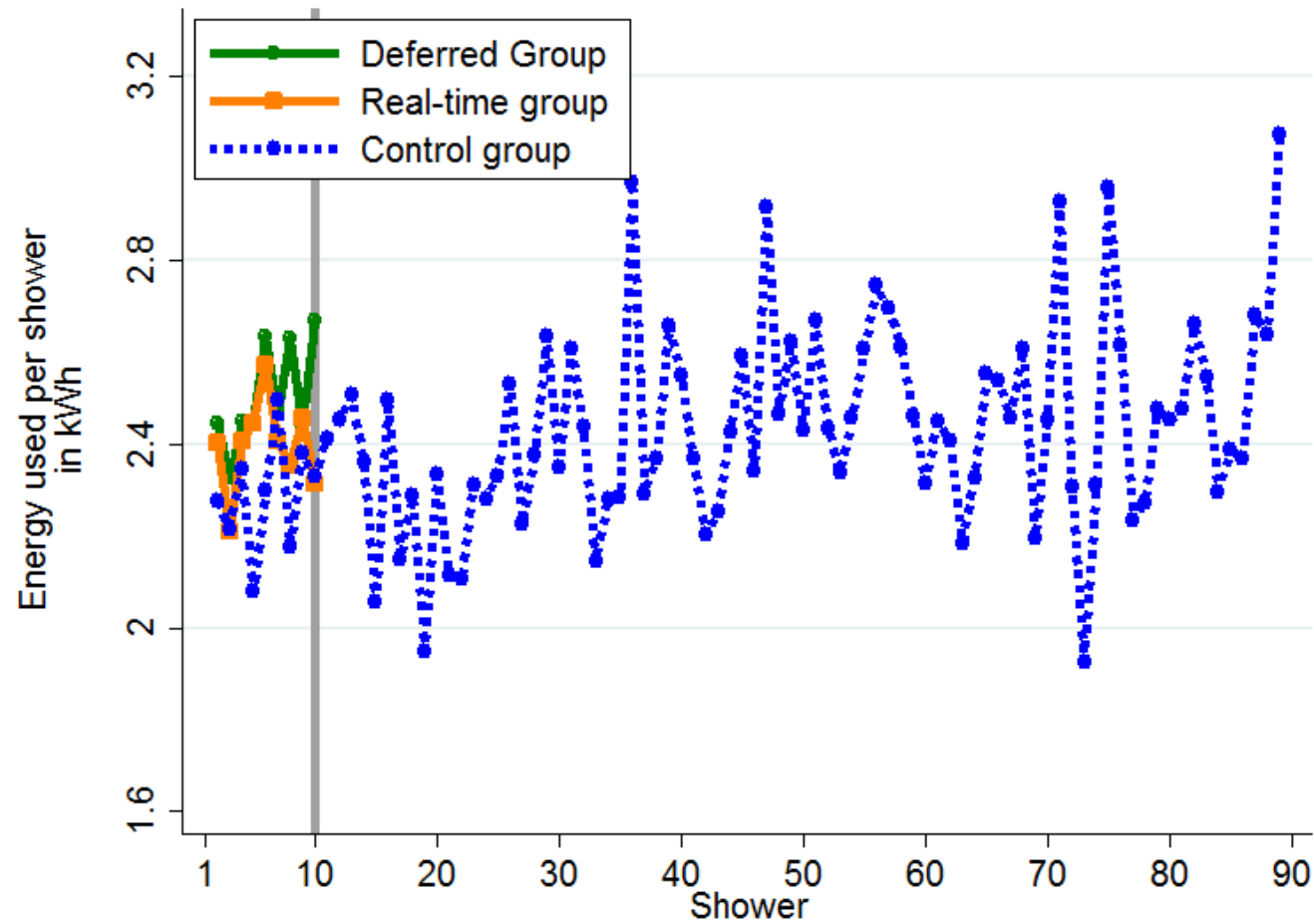
→ **Again, households in the real-time group reduce their energy use per shower by 22% (difference-in-differences analysis).**
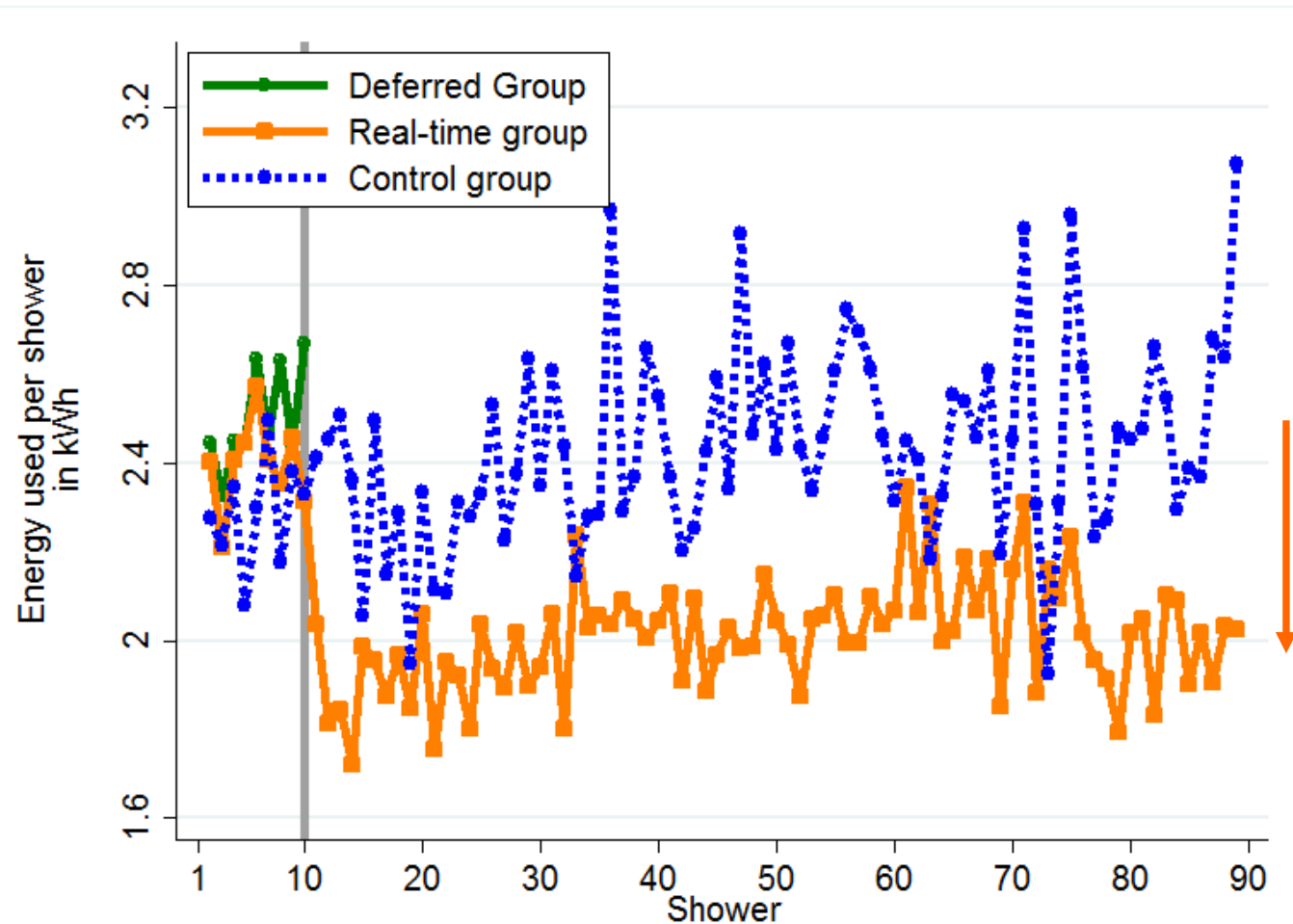
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Sorry, the next two slides are not available online.

→ **The effect of behavior-specific real-time feedback is immediate. In both studies, the effect was stable throughout the two-month study duration.**

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Other results on the impact of behavior-specific real-time feedback:

- Effects are **immediate** (full effect size in first shower with feedback)

- Effects are **stable** throughout the 2-month study

- **No impact** on shower **frequency**
    - Shorter showers are not compensated by more frequent showers
    - No undesirable side effects on cleanliness

- **High-users** reduce their energy consumption most

- Survey data to tweak out **behavioral mechanisms**…

Netherlands, 600 devices

Switzerland, 2 x 700 devices

South Korea, 100 devices

Singapore, 900 devices

Partner organizations:

amphiro

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Bundesamt für Energie BFE

PUB
Water for All: Conserve, Value, Enjoy

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PWN

KEMCO

Thank you very much for your attention!

Questions?

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